

## ***Interactive comment on “Flood Impacts on Emergency Responders Operating at a City-Scale” by Daniel Green et al.***

**Daniel Green et al.**

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In the following response, the comments of the referee are printed in **black** and author replies in **blue**. **Red** text refers to proposed changes to the manuscript text.

### **1. General comment:**

The paper by Green et al. presents a GIS based methodology to assess Ambulance and Fire & Rescue responses during 1-20, 1-100 and 1-1,000-year surface and fluvial flooding events. The main results show the decrease in the emergency service accessibility proportional to the extent of the flood event, and the authors argue that these results can guide strategic planning for decision makers on the response to flood events. The paper is very well written, and explains clearly the methodology used, which is based on existing data and models. My main comment is related to use the word “transport modelling” in this work, however, the authors have clearly recognised the limitations of their approach in the Conclusions section. As such I find that the manuscript would be suitable for publication if the authors would address two minor comments discussed in more detail below.

C1

Thank you for your constructive comments on our manuscript. We are glad that you find the manuscript suitable for publication and that you believe the methodology is clearly communicated.

### **2. Specific comments:**

**2.1** In the Introduction, the authors say that the paper describes “a novel approach to evaluate and forecast the impacts of surface water and fluvial flood events... on emergency responders operating at the city scale...”. I would like to see more detailed explanation what exactly is the novelty in the presented methodology.

The methodology is novel due to the visualisation and presentation of the data, with accessibility expressed in relation to the Ambulance and Fire & Rescue Service response timeframes (8- and 10-minutes respectively) for high priority, life threatening incidents. Furthermore, the transferability of the methodology to other hazards and case study locations using readily available datasets makes it a novel and applied approach to understanding spatial accessibility.

In addition, can the authors please explain how the approach could be used in the forecasting mode.

The term “forecasting” was used in the sense that the method is able to predict the impacts of surface water and fluvial flood events of differing, scenario-based magnitudes on emergency responder accessibility. The word “forecast” has been replaced with “model” at Line 100 to clarify this point:

“This paper describes a novel approach to model and evaluate the impacts of surface water and fluvial flood events of varying magnitudes on emergency responders operating at the city scale using readily available datasets and functions within a GIS software package (ArcGIS).”

Because the methodology uses flood restrictions as an input, forecasting the impacts of actual flood events on emergency service response could be undertaken by conducting real-time, city-scale hydrodynamic inundation modelling and inputting the depth over threshold value ( $\geq 25$  cm) into the network analysis framework. Real-time precipitation or river flow data could be obtained from rain gauges, flow gauges or radar data to forecast accessibility for actual flood events. Instead, this pilot study undertaken uses design storm scenarios of known magnitudes (1 in 20-, 1 in 100- and 1 in 1,000-year events).

The changing of the word “forecasting” to “model” (above) should clarify this point. Furthermore, the Conclusion (Lines 443 - 445) has been amended to explain how the methodology could be adapted to allow real-time forecasting, rather than scenario or event-based studies:

“Further study may be directed at coupling nowcast meteorological data (e.g. radar, rain gauge or river flow data) with city-scale hydrodynamic inundation models to provide real-time flood restriction data into the network analysis framework. This could be used to inform operational response and decision making during actual flood events.”

C2

2.2 The main purpose of this work is to provide the information to inform the decision making on planning the transport routes during flooding events. The literature review section would benefit from a more detailed overview of the current approaches to decision making during flood events, and where this work fits within existing frameworks.

We agree that the manuscript would benefit from a short inclusion on current decision making approaches during flood events. Lines 71 - 79 sum up the current legislative approaches to decision making during flood events but further detail on how this work could enhance existing frameworks could be added. The following has been added at Line 79, carrying on from the current legislative approaches. Lines 71 - 86 have also been split into two paragraphs at Line 79 to clarify the points made in this paragraph.

“Currently, decision making during flood events and knowledge of flood prone areas is informed by planning exercises coordinated by emergency responder organisations, local understanding and past experience of areas prone to flooding, as well as identification of flood hotspot areas based on flood modelling studies undertaken (see Section 2.1). However, these approaches only show the locations of direct flood risk and cannot be used to understand the indirect impacts of flooding on emergency responder operation and accessibility. An applied understanding of the spatio-temporal impacts of flood events on emergency responder accessibility may enhance existing contingency planning frameworks by providing foresight into the potential bottleneck locations across the city which may ultimately increase emergency responder resilience and preparedness during flood events.”